Homogeneous Nucleation and its role in CRYSTAL-FACE anvil cirrus
Part I: Observations

Andrew Heymsfield, Aaron Bansemer, Michael Poellot, Cynthia Twohy, Hermann Gerber, and Ann Fridlind

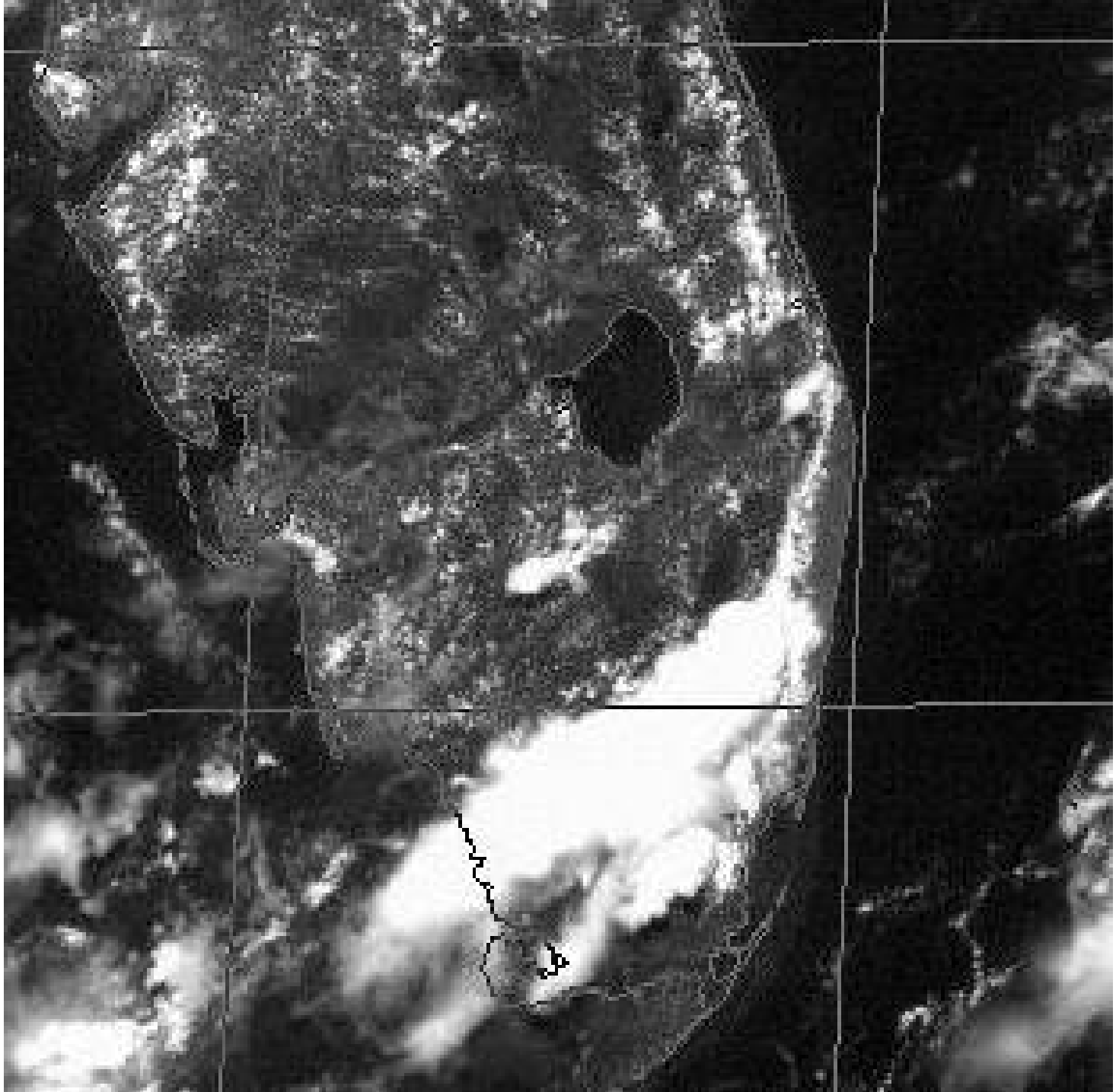
Motivation

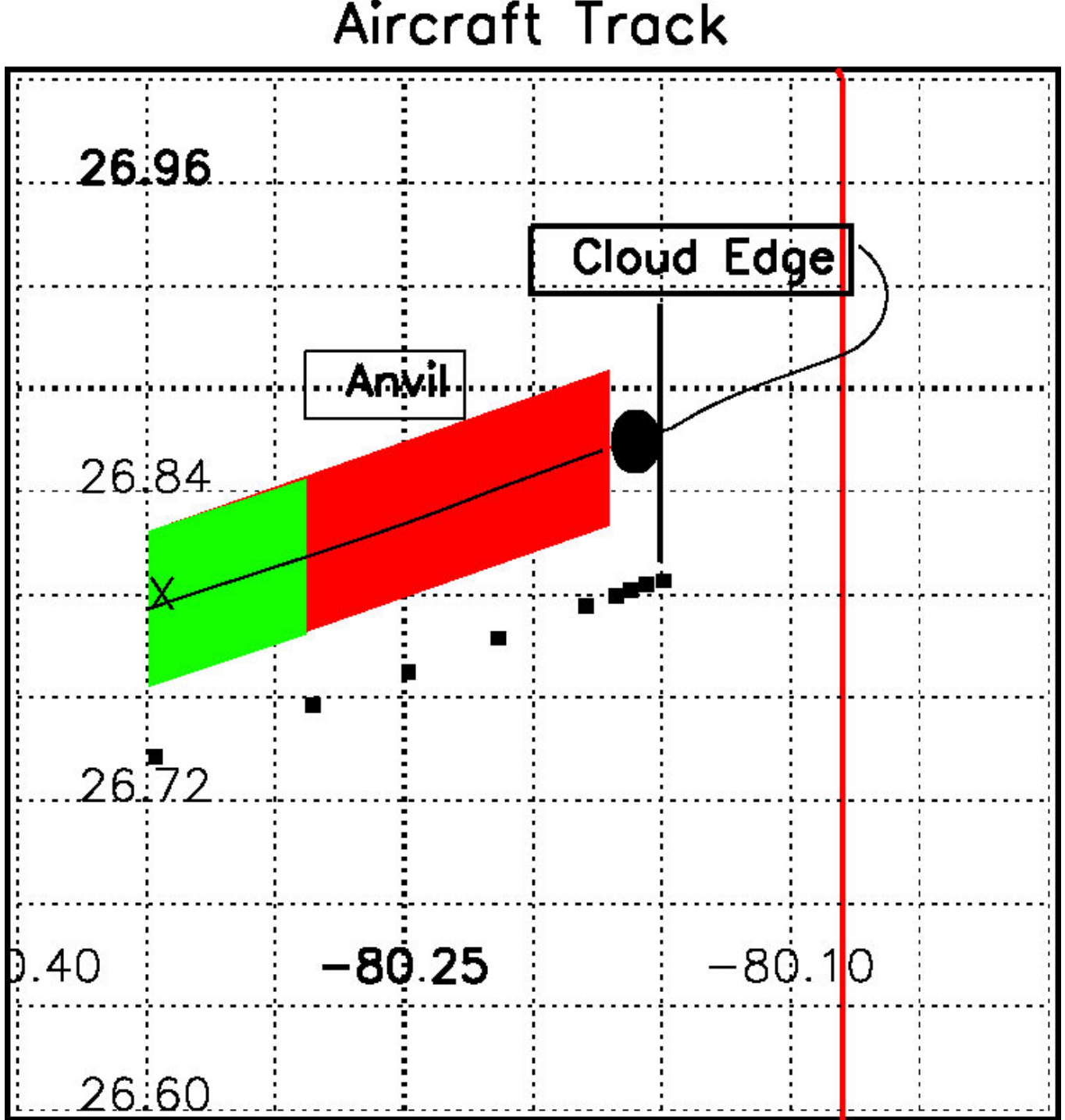
- How do cirrus anvil size, lifetime, microphysical properties, and optical properties depend upon the intensity of the generating convective systems

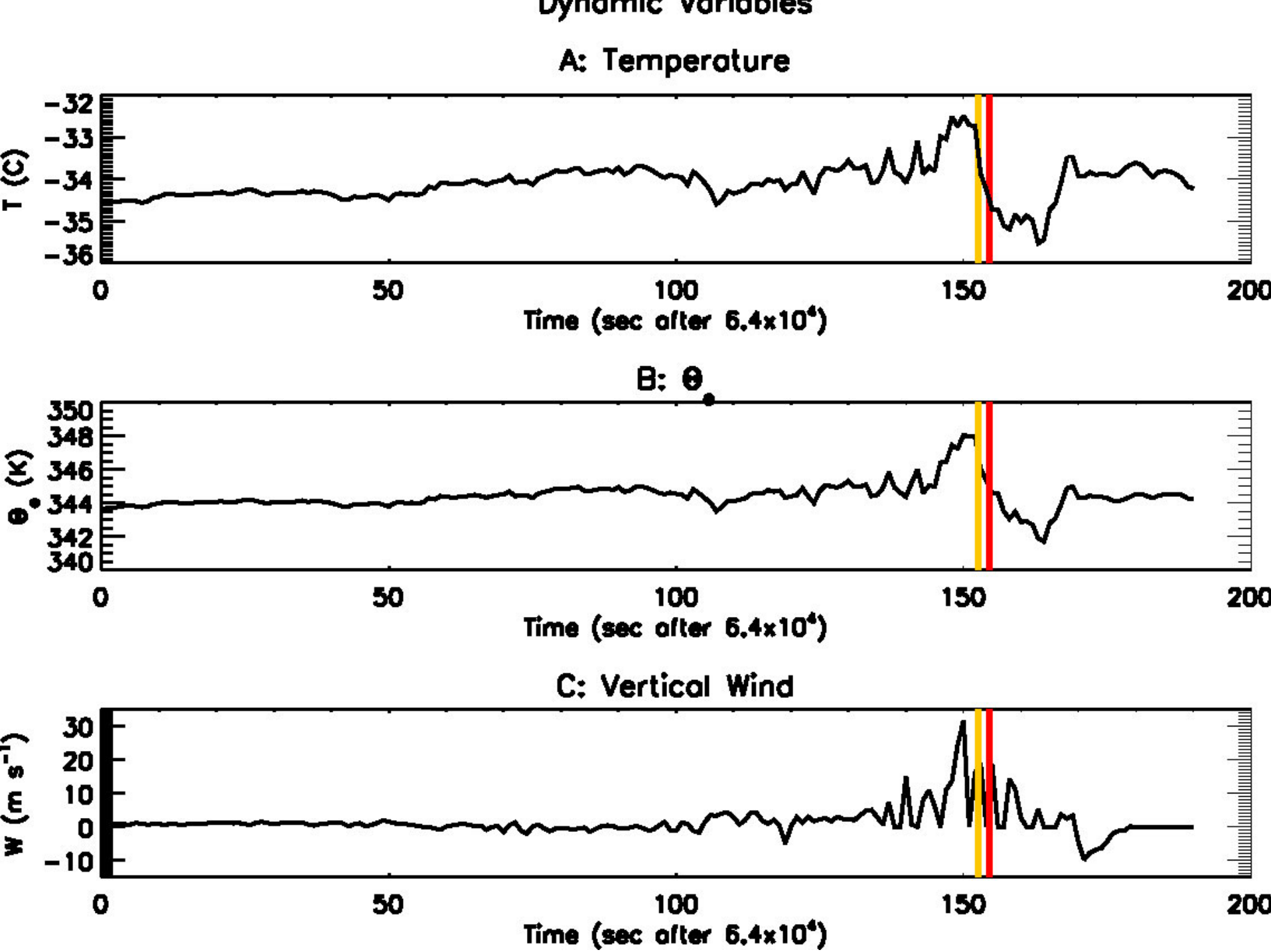
- Are the anvil ice number densities consistent with our understanding of ice nucleation in convective updrafts, dilution by entrainment, and precipitation?

Primary Instruments

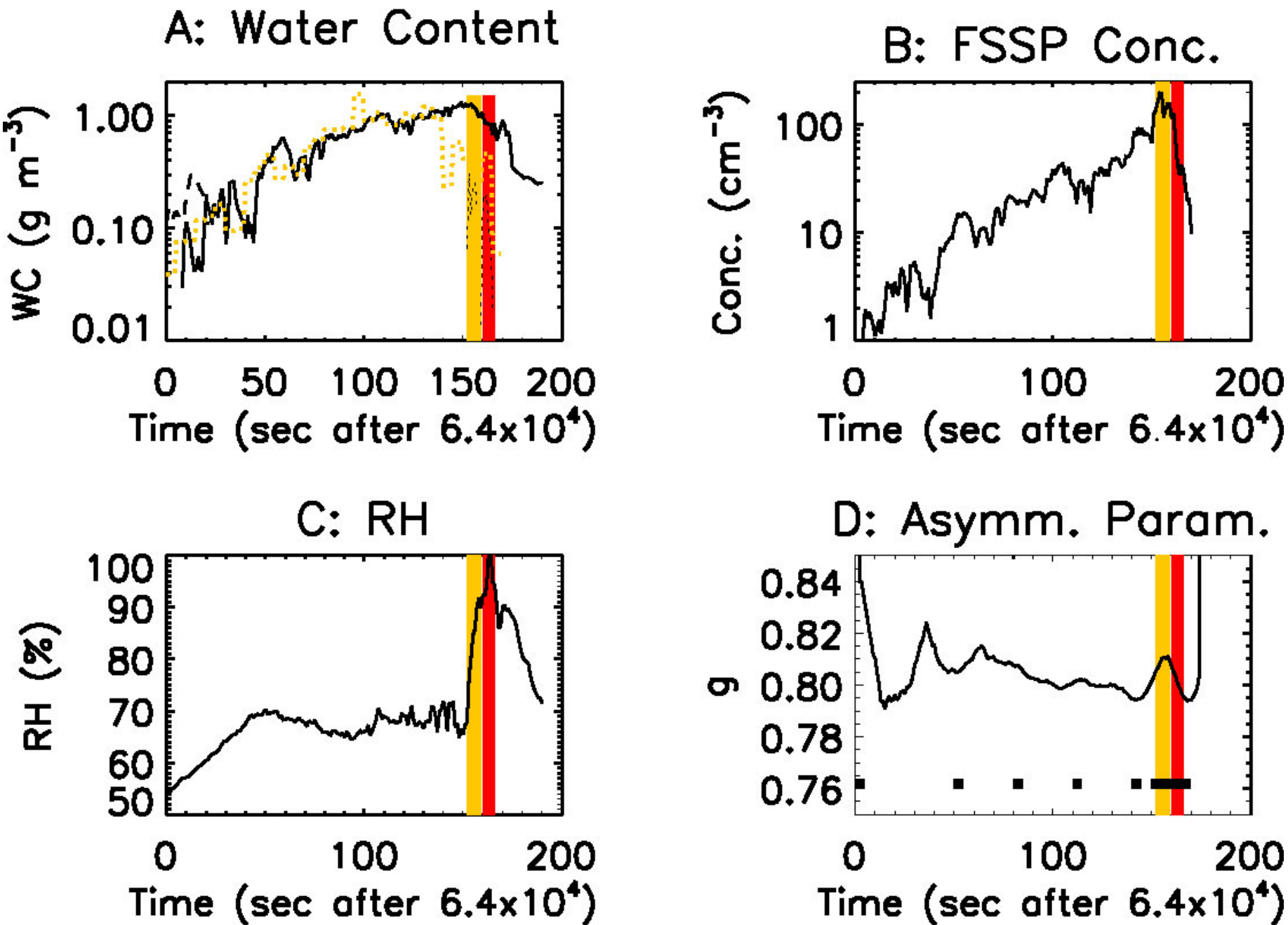
- UND Citation
- Particle Probes: 2D, HVPS, FSSP, CPI
- RICE, King
- CVI
- CIN
- Temperature, Vertical Velocity Msmts.

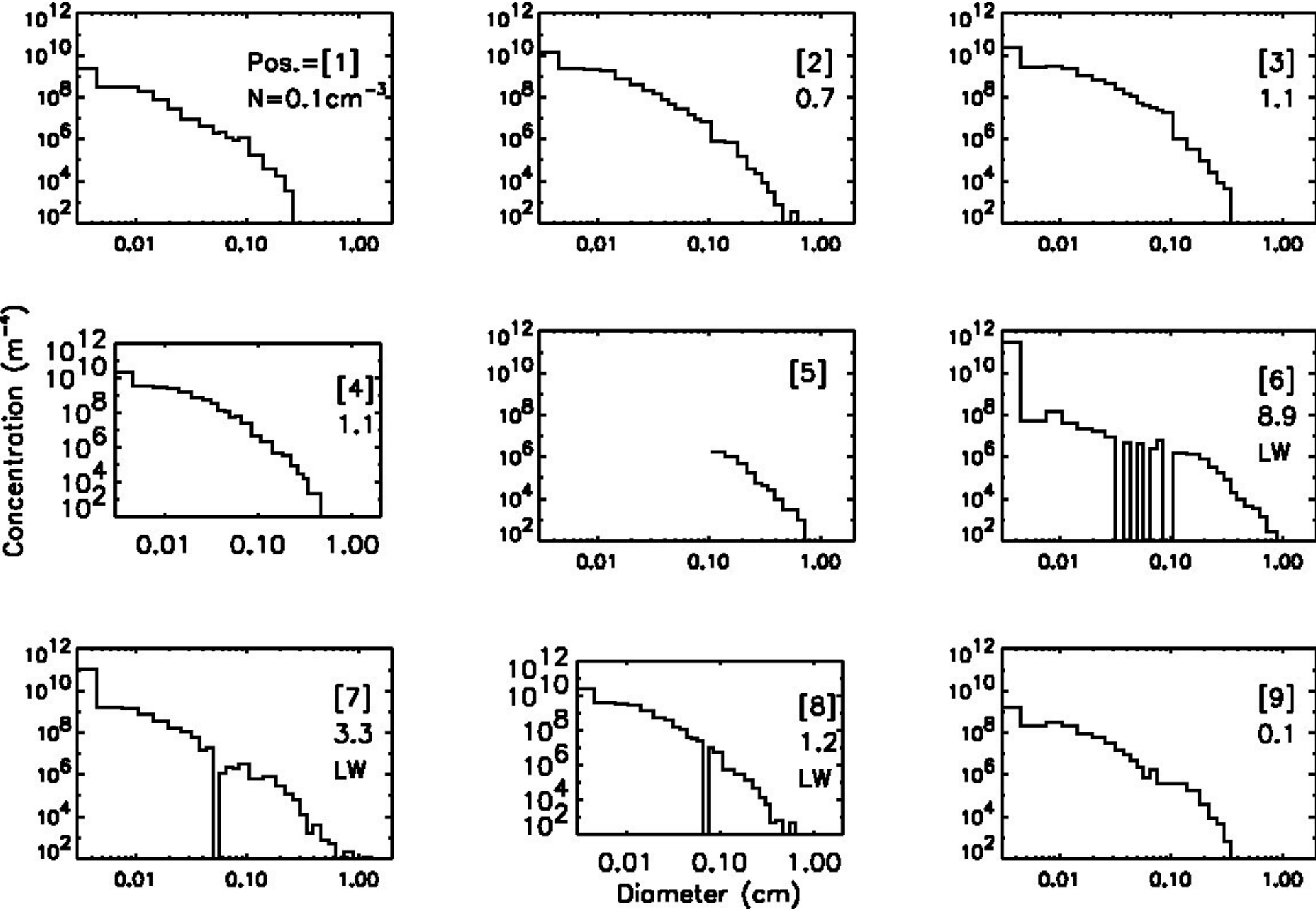


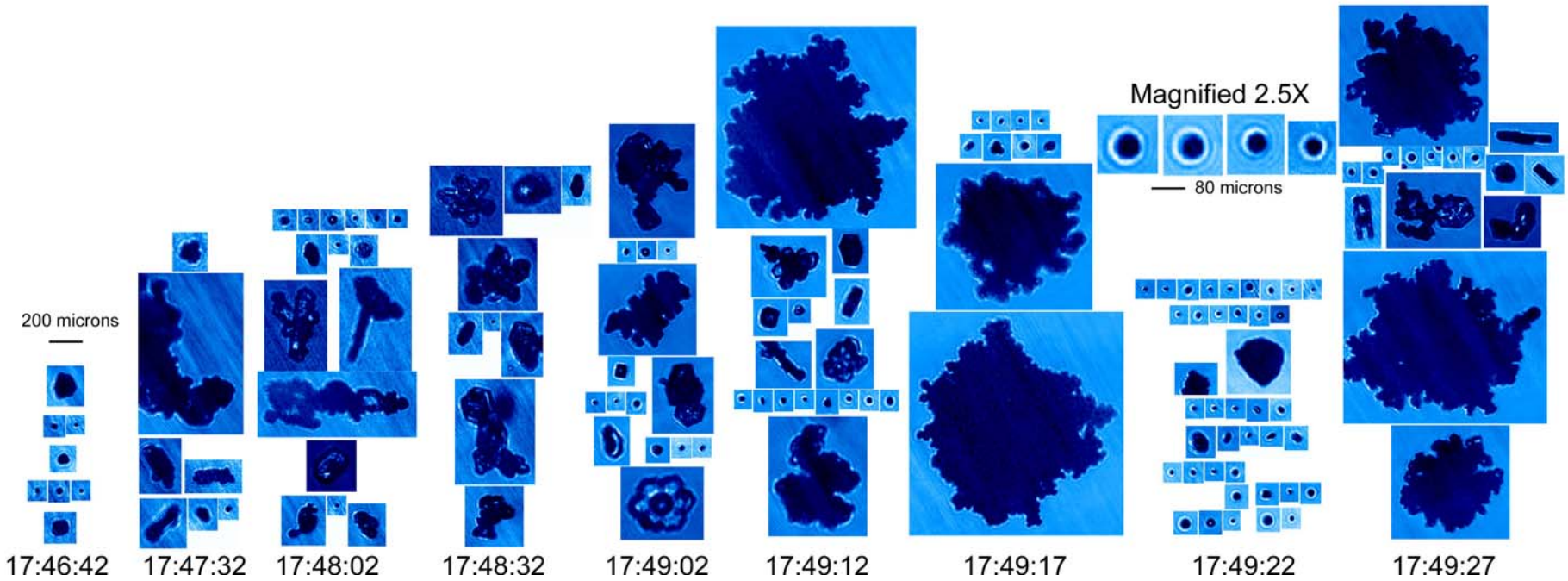

Aircraft Track
26.96
Cloud Edge
Anvil
26.84
26.72
.40
-80.25
-80.10
26.60

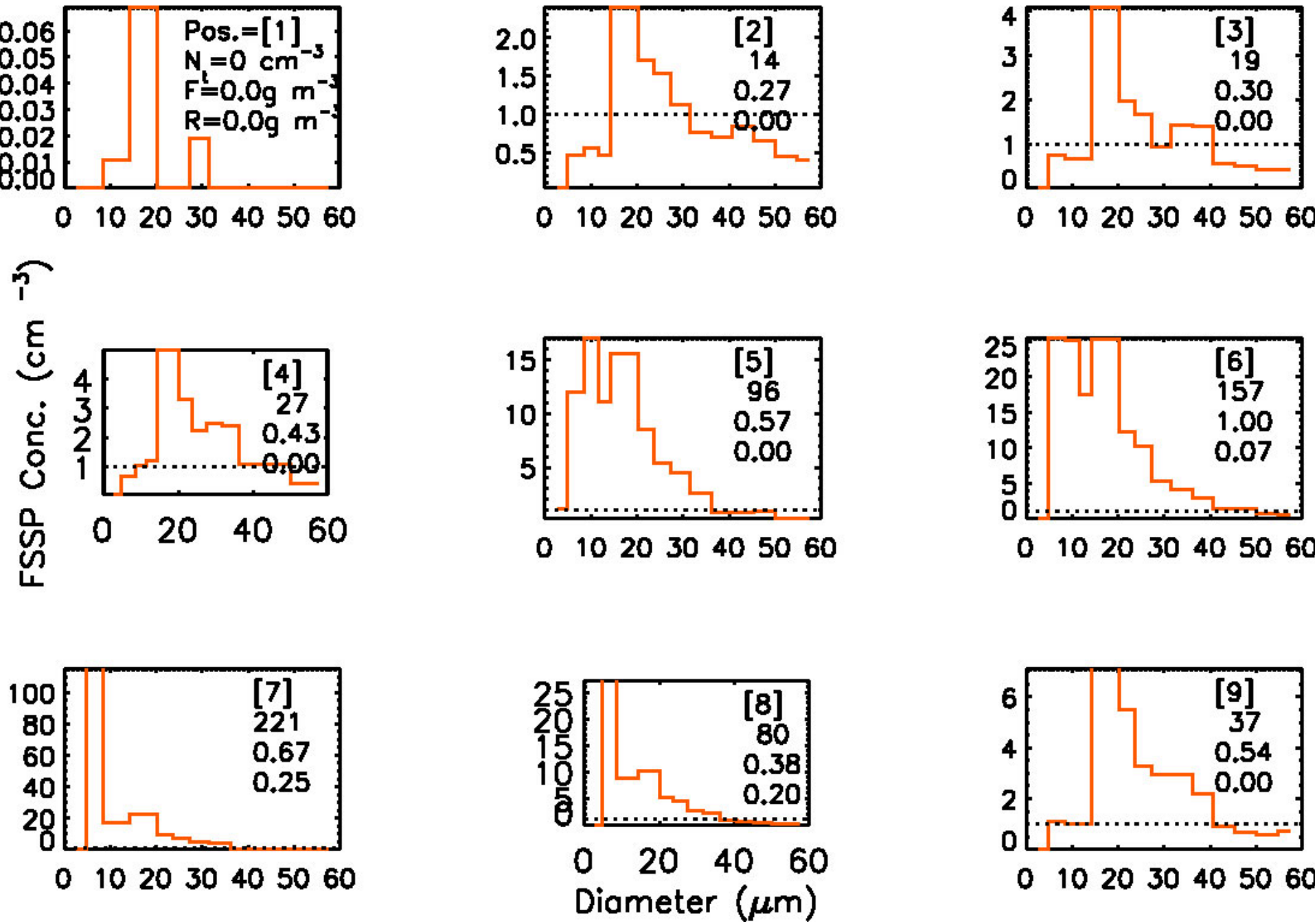

Dynamic Variables
A: Temperature
T (C)
-32
-33
-34
-35
-36
0
50
100
150
200
Time (sec after 6.4x10⁴)
B: θe
θe (K)
350
348
346
344
342
340
0
50
100
150
200
Time (sec after 6.4x10⁴)
C: Vertical Wind
W (m s⁻¹)
30
20
10
0
-10
0
50
100
150
200
Time (sec after 6.4x10⁴)

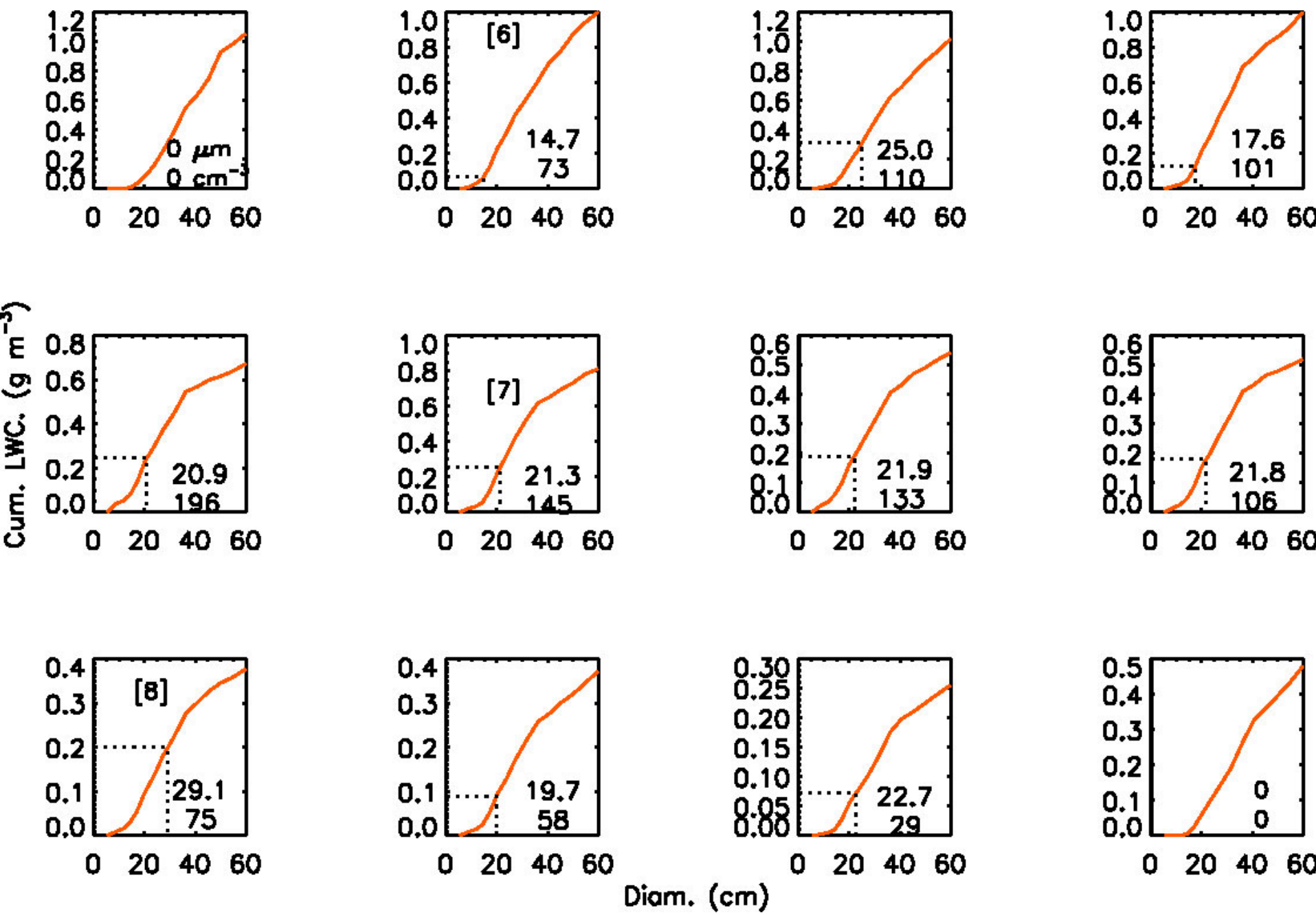
Updraft Region Observations

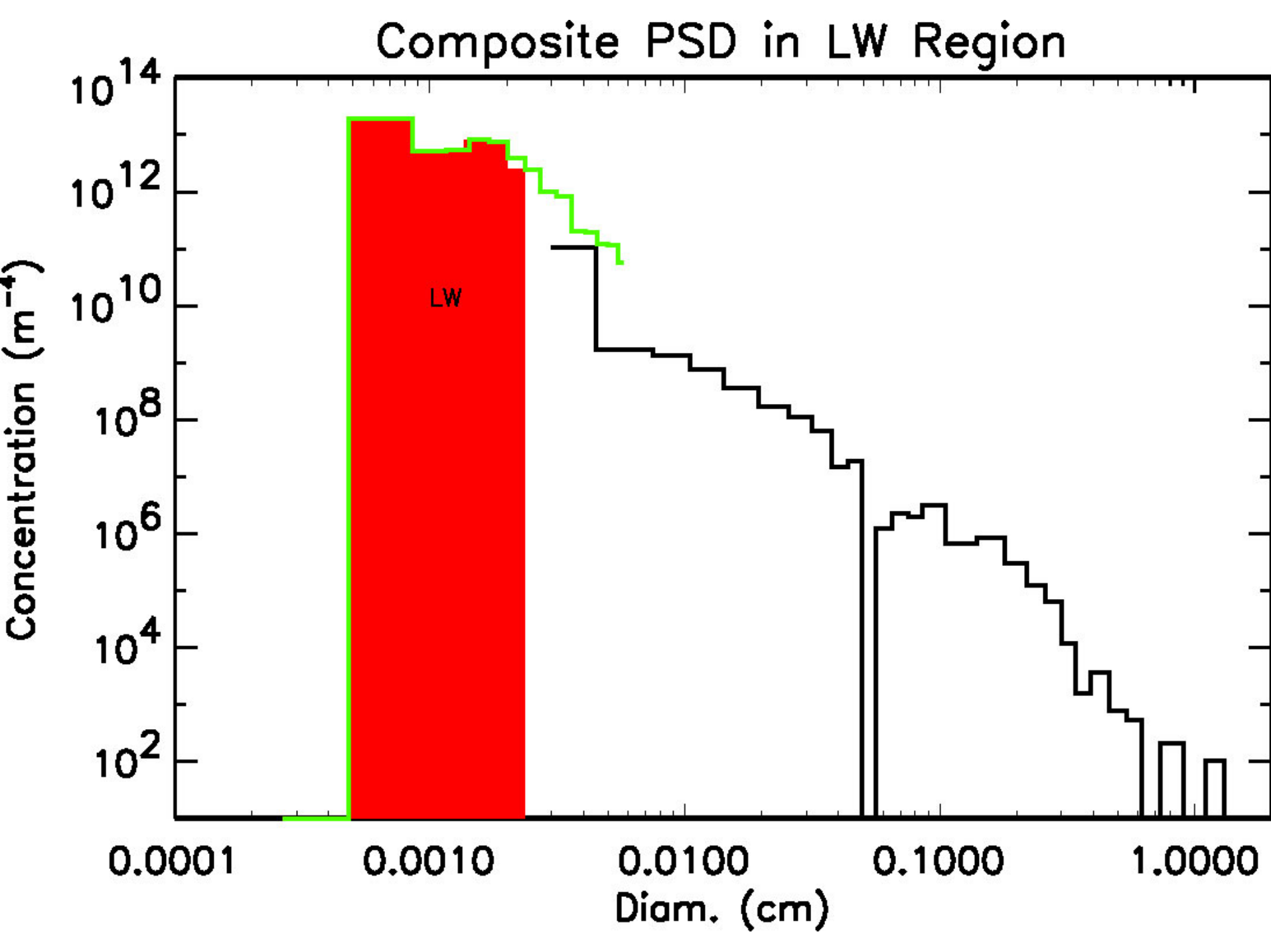



Pos.=[1]
N=0.1cm^{-3}
[2]
0.7
[3]
1.1
[4]
1.1
[5]
[6]
8.9
LW
[7]
3.3
LW
[8]
1.2
LW
[9]
0.1
Concentration (m^{-4})
Diameter (cm)
0.01
0.10
1.00

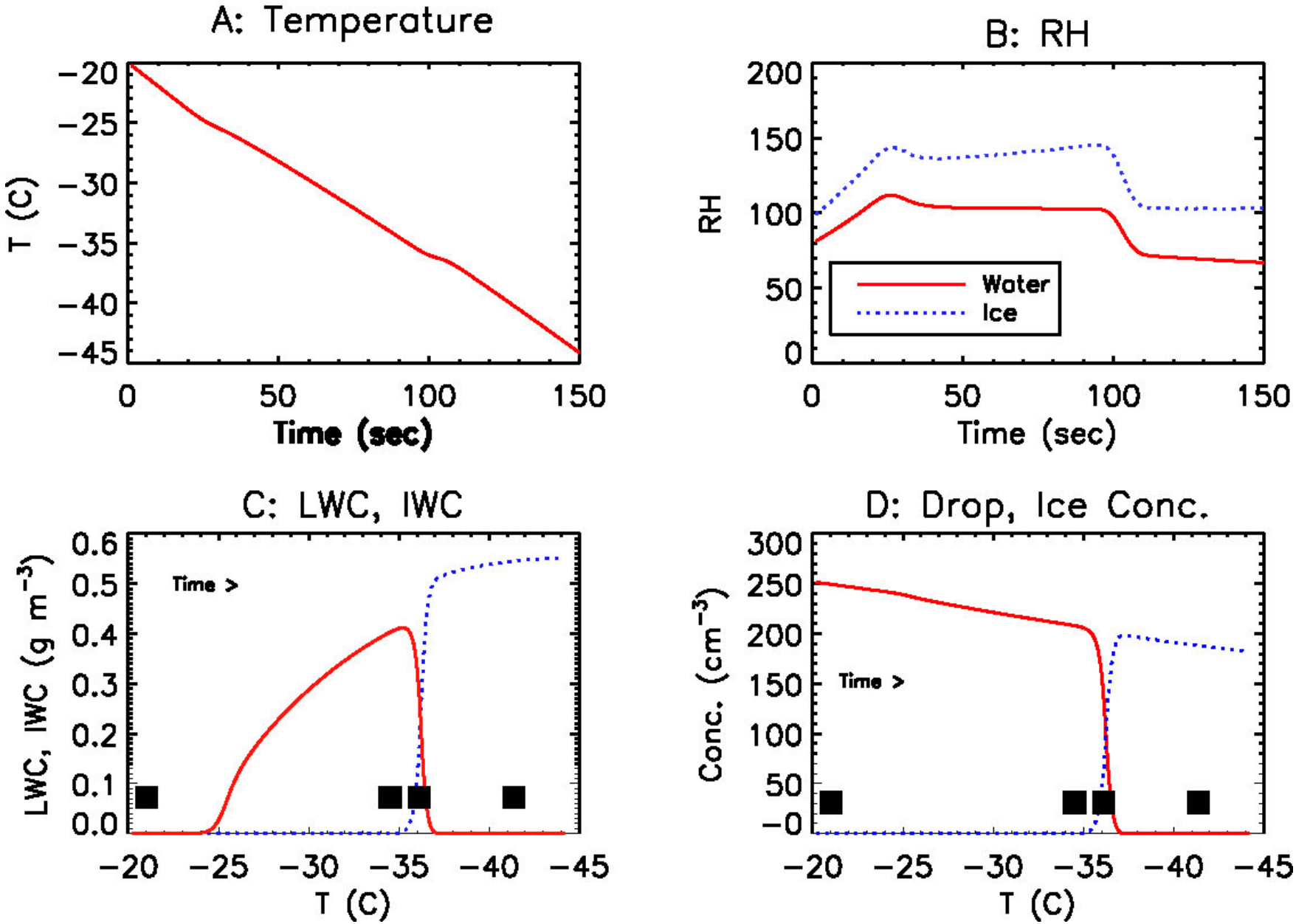

200 microns
Magnified 2.5X
80 microns
17:46:42
17:47:32
17:48:02
17:48:32
17:49:02
17:49:12
17:49:17
17:49:22
17:49:27

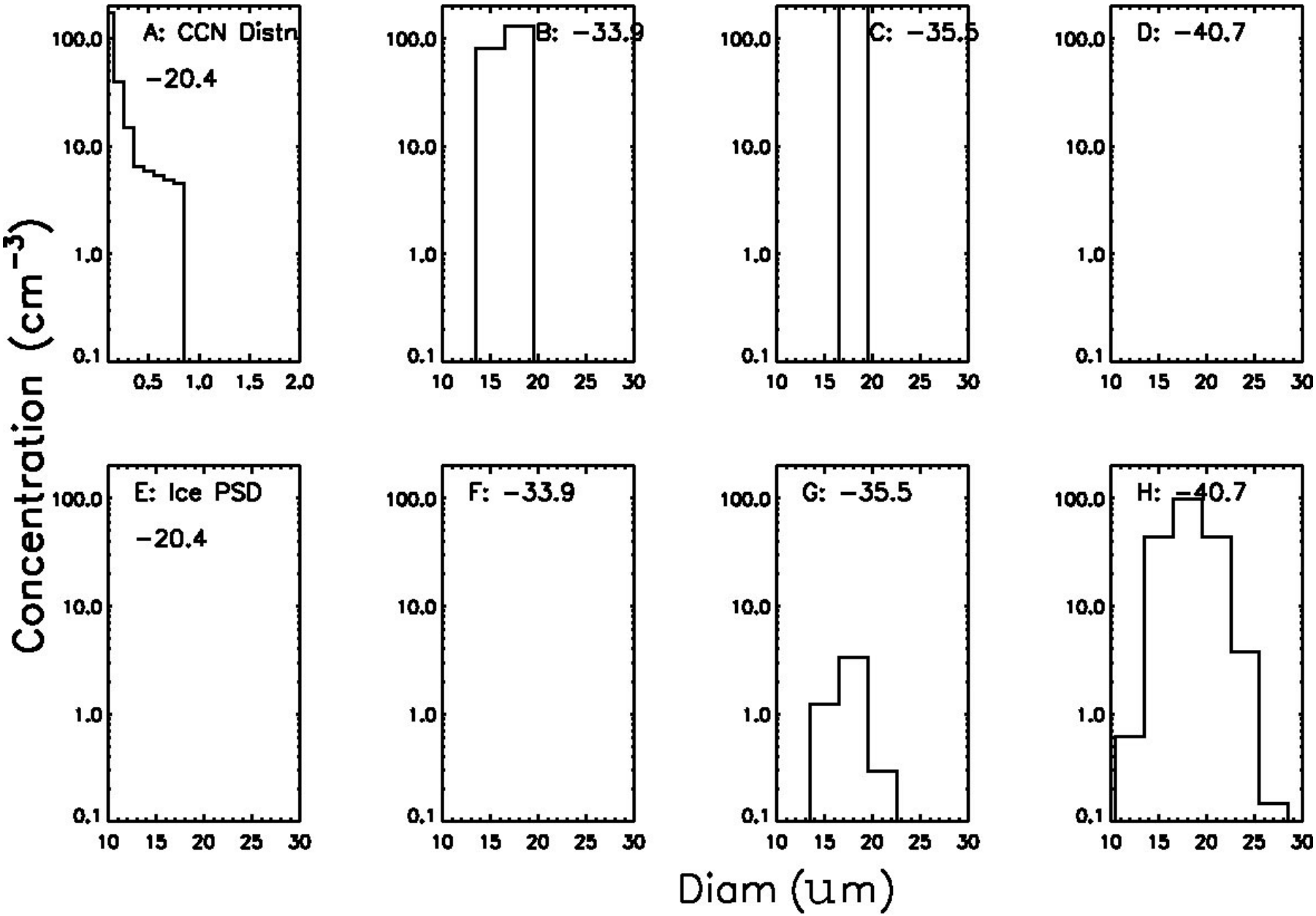

Pos.=[1]
N=0 cm⁻³
F=0.0g m⁻³
R=0.0g m⁻³
[2]
14
0.27
0.00
[3]
19
0.30
0.00
[4]
27
0.43
0.00
[5]
96
0.57
0.00
[6]
157
1.00
0.07
[7]
221
0.67
0.25
[8]
80
0.38
0.20
[9]
37
0.54
0.00
FSSP Conc. (cm⁻³)
Diameter (μm)

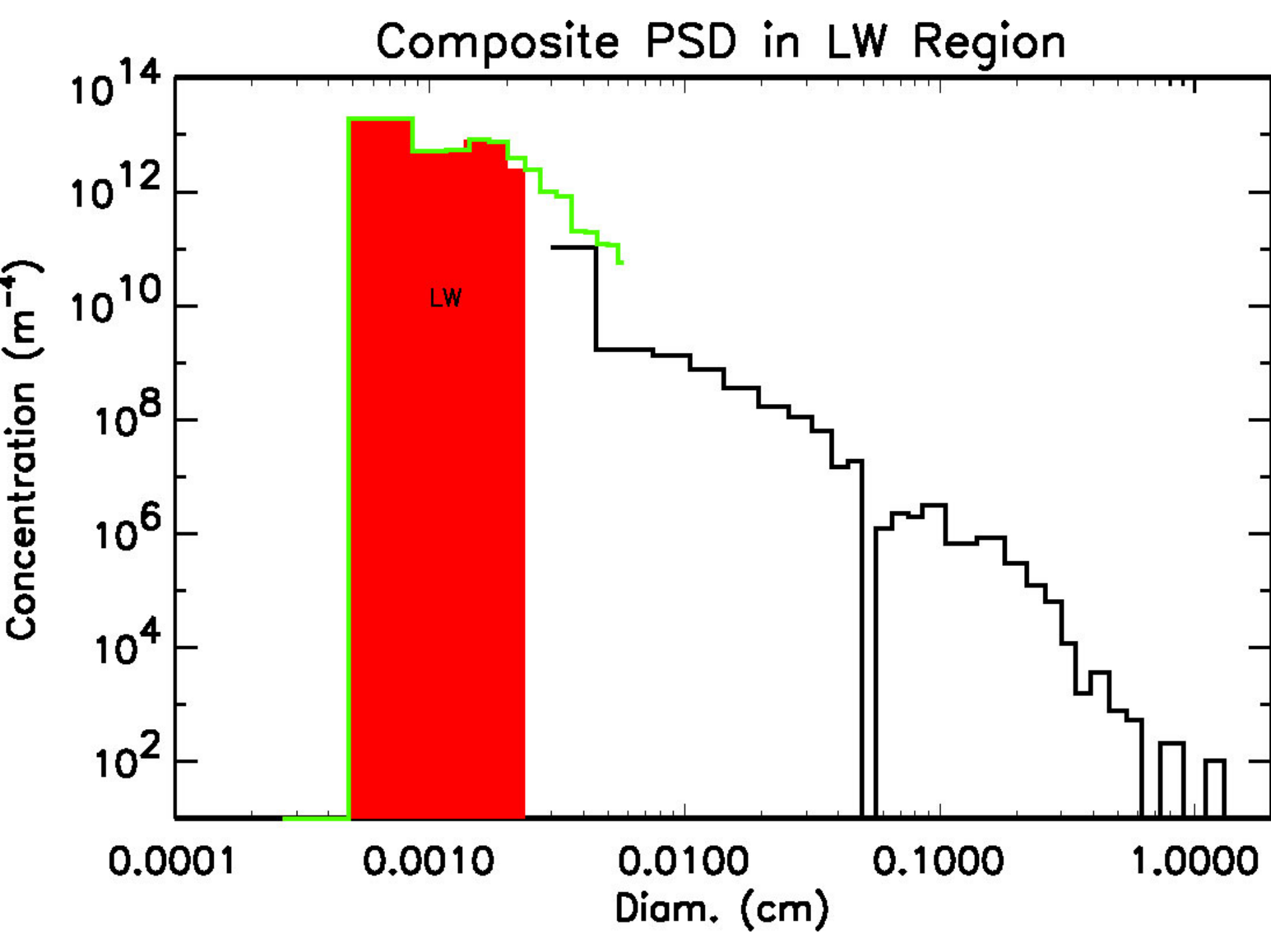

0 μm
0 cm⁻³
[6]
14.7
73
25.0
110
17.6
101
20.9
196
[7]
21.3
145
21.9
133
21.8
106
[8]
29.1
75
19.7
58
22.7
29
0
0
Cum. LWC. (g m⁻³)
Diam. (cm)


Composite PSD in LW Region
LW
Concentration (m^{-4})
10^{14}
10^{12}
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}
0.0001
0.0010
0.0100
0.1000
1.0000
Diam. (cm)

Model Calculations




A: CCN Distn
-20.4
B: -33.9
C: -35.5
D: -40.7
E: Ice PSD
-20.4
F: -33.9
G: -35.5
H: -40.7
Concentration (cm-3)
Diam (um)
100.0
10.0
1.0
0.1
0.5
1.0
1.5
2.0
10
15
20
25
30


Composite PSD in LW Region
LW
Concentration (m^{-4})
10^{14}
10^{12}
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}
0.0001
0.0010
0.0100
0.1000
1.0000
Diam. (cm)

SUMMARY AND CONCLUSIONS

- Demonstrated a case of homogeneous ice nucleation in CRYSTAL-FACE updrafts
- Ice concentrations are of order several hundred per cc
- Non-homogeneous ice nucleation component in PSD tail amounts to concentrations of several tenths per cc, much affect homog. process
- Cloud droplet sizes at -34C are 7 to 20 microns in concentrations of cc. Surprisingly, large cloud droplets up to 70 microns diameter in updraft are found,.
- Model appears in general to simulate the homogeneous ice nucleation component
- In weaker updraft regions as in tropical convection, much lower concentrations of ice are found from the model.